



Behavioral Health and Performance

OCHMO-TB-016
Rev B

Executive Summary

Crew behavioral health and performance are affected by missions in isolated, confined, and extreme (ICE) environments. Future exploration missions will involve humans moving further away from low Earth orbit (LEO) with longer mission durations and will have a greater risk for behavioral health and performance decrements. These hazards could lead to (a) adverse cognitive or behavioral conditions affecting crew health and performance during the mission; (b) the development of psychiatric disorders if adverse behavioral health conditions are undetected or inadequately mitigated; and c) long-term health consequences, including late-emerging cognitive and behavioral changes. Ensuring crew behavioral health over the long term is essential. Behavioral health standards optimize crewmembers' health, well-being, and productivity and reduce the risk of behavioral and psychiatric conditions before, during, and after missions.



Relevant Technical Requirements

NASA-STD-3001 Volume 1, Rev C

- [V1 3001] Selection and Recertification
- [V1 3002] Pre-Mission Preventive Health Care
- [V1 3003] In-Mission Preventive Health Care
- [V1 3004] In-Mission Medical Care
- [V1 3050] Pre-Mission Crew Mortality Plan
- [V1 3052] In-Mission Forensic Sample Collection
- [V1 3055] Surviving Crew Support
- [V1 4011] Mission Cognitive Status
- [V2 4014] Completion of Critical Tasks
- [V1 5002] Crewmember Training
- [V1 5008] Psychological Mission Training
- [V1 6001] Circadian Shifting Operations and Fatigue Management
- [V1 6002] Private Medical Communication (PMC) Schedule
- [V1 6004] Behavioral Health and Performance Provisions
- [V1 6010] Psychological Communication Schedule

NASA-STD-3001 Volume 2, Rev D

- [V2 3006] Human-Centered Task Analysis
- [V2 4102] Functional Anthropometric Accommodation
- [V2 5007] Cognitive Workload
- [V2 10200] Physical Workload
- [V2 6022] Atmospheric Monitoring and Alerting Parameters
- [V2 6013] Crew Performance Environmental Zone
- [V2 6017] Atmospheric Control



Executive Summary (continued)



Relevant Technical Requirements

- [V2 6109] Water Quantity
- [V2 6110] Water Temperature
- [V2 6115] 24-Hour Noise Exposure Limits
- [V2 6078] Continuous Noise Limits
- [V2 6079] Crew Sleep Continuous Noise Limits
- [V2 6080] Intermittent Noise Limits
- [V2 6082] Annoyance Noise Limits for Crew Sleep
- [V2 6083] Impulse Noise Limit
- [V2 6092] Vibration Exposure Limits during Sleep
- [V2 6093] Vibration Limits for Performance
- [V2 6095] Ionizing Radiation Protection Limit
- [V2 6161] Intravehicular Area Monitoring of Space Radiation Exposure
- [V2 6162] Personal Monitoring of Space Radiation Exposure
- [V2 6164] Alerting of Elevated Exposure Rates
- [V2 6165] External Space Weather Monitoring
- [V2 7002] Food Acceptability
- [V2 7008] Food Preparation
- [V2 7012] Dining Accommodations
- [V2 7016] Personal Hygiene Capability
- [V2 7017] Body Cleansing Privacy
- [V2 7021] Body Waste Management System Location
- [V2 7022] Body Waste Management Privacy
- [V2 7038] Physiological Countermeasures Capability
- [V2 7050] Stowage Provisions
- [V2 7051] Personal Stowage
- [V2 7061] Nomenclature Consistency
- [V2 7062] Unique Item Identification
- [V2 7063] Interchangeable Item Nomenclature
- [V2 7070] Sleep Accommodation



Relevant Technical Requirements

- [V2 7071] Behavioral Health and Privacy
- [V2 7073] Partial-g Sleeping
- [V2 8001] Volume Allocation
- [V2 8005] Functional Arrangement
- [V2 8013] Intravehicular Translation Paths
- [V2 8033] Restraints for Crew Tasks
- [V2 8049] Window Light Blocking
- [V2 8050] Window Accessory Replacement/Operation without Tools
- [V2 8055] Physiological Effects of Light (Circadian Entrainment)
- [V2 8056] Lighting Controls
- [V2 9057] Hearing Protection Provision
- [V2 11010] EVA Suit Radiation Monitoring

Section 10: Crew Interfaces



Houston We Have a Podcast:

NASA chats with the rock band Shinedown about the similarities and importance of mental health for orbiting astronauts, touring band members... and everyone!

[Ep94: Mental Health with Shinedown | NASA](#)

Background

Space flight occurs in an extreme environment that has unique stressors. Common behavioral health conditions or concerns in the spaceflight environment may include stress, depression, anxiety, relationship problems, and grief. The condition can be temporary, resolving with time and/or intervention, or can develop into a psychiatric disorder. Assessing predictive and contributing factors related to behavioral health can help prevent the onset of distress.

Behavioral Health Contextual Factors

Individual Factors

- Demographics and biological resilience
- Personality
- Coping styles
- Culture and language
- Family and life stressors
- Major world events

Social/Crew Dynamics

- Crew size
- Social climate/cohesion
- Group living and team care skills

Behavioral Health Decrements Contributing Factors

- Sleep
- Workload
- Human System Integration Architecture (HSIA)
- Pharmacotherapeutics (adverse effects)
- Medical conditions
- Hypoxia
- Food and nutrition
- Carbon dioxide exposure

Consequences of Behavioral Health Decrements

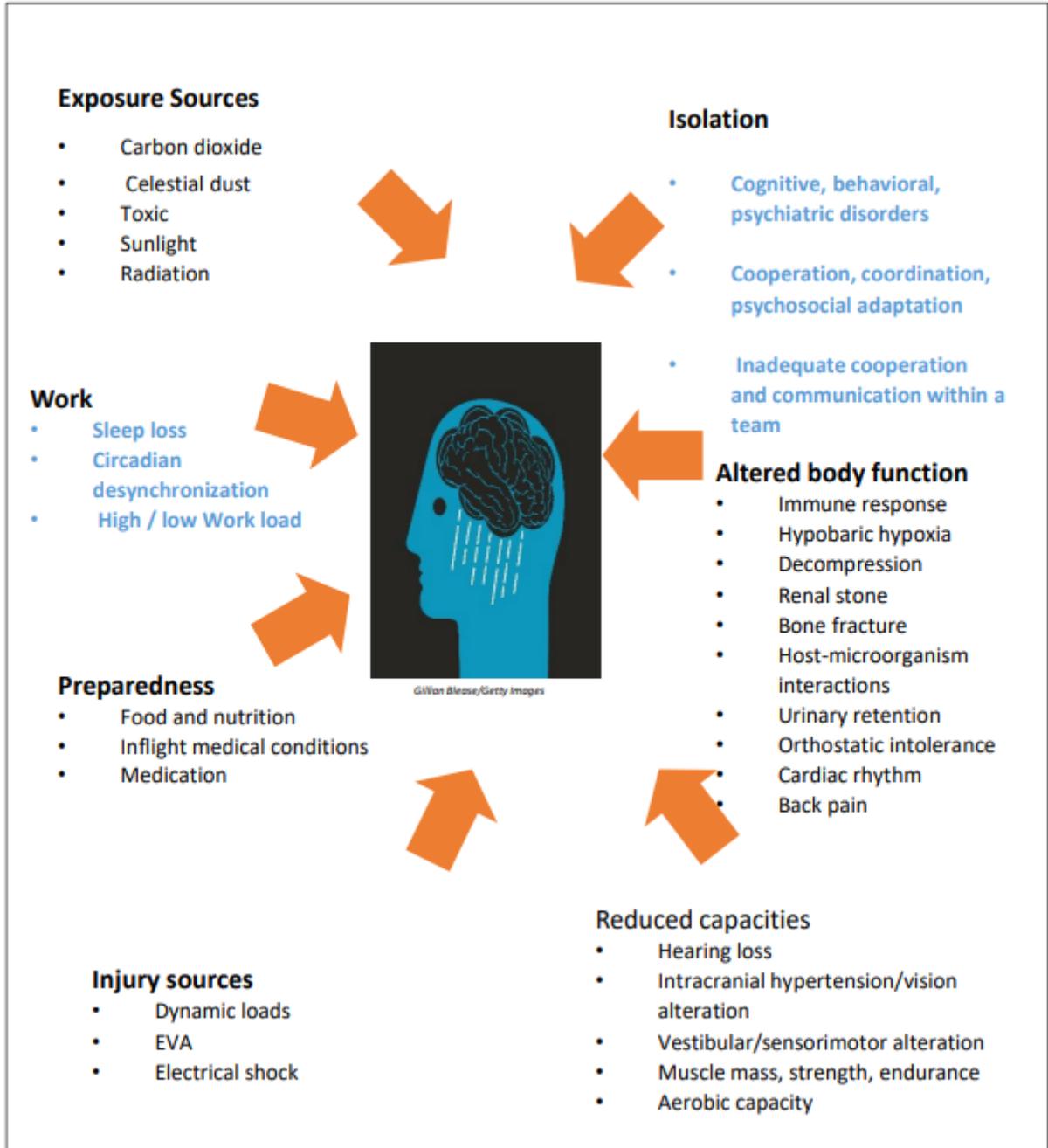
- Operational performance decline (that might lead to loss of mission objectives or loss of mission (e.g., evacuation/early return)
- Psychiatric disorders
- Neurocognitive or neurodegenerative disorders



NASA SpaceX Crew-6 astronauts stand inside the crew access arm leading to the SpaceX Dragon spacecraft Endeavour at NASA's Kennedy Space Center. *Photo: NASA*

Background

Factors that affect crewmembers behavioral health



*Primary factors that affect crewmembers behavioral health



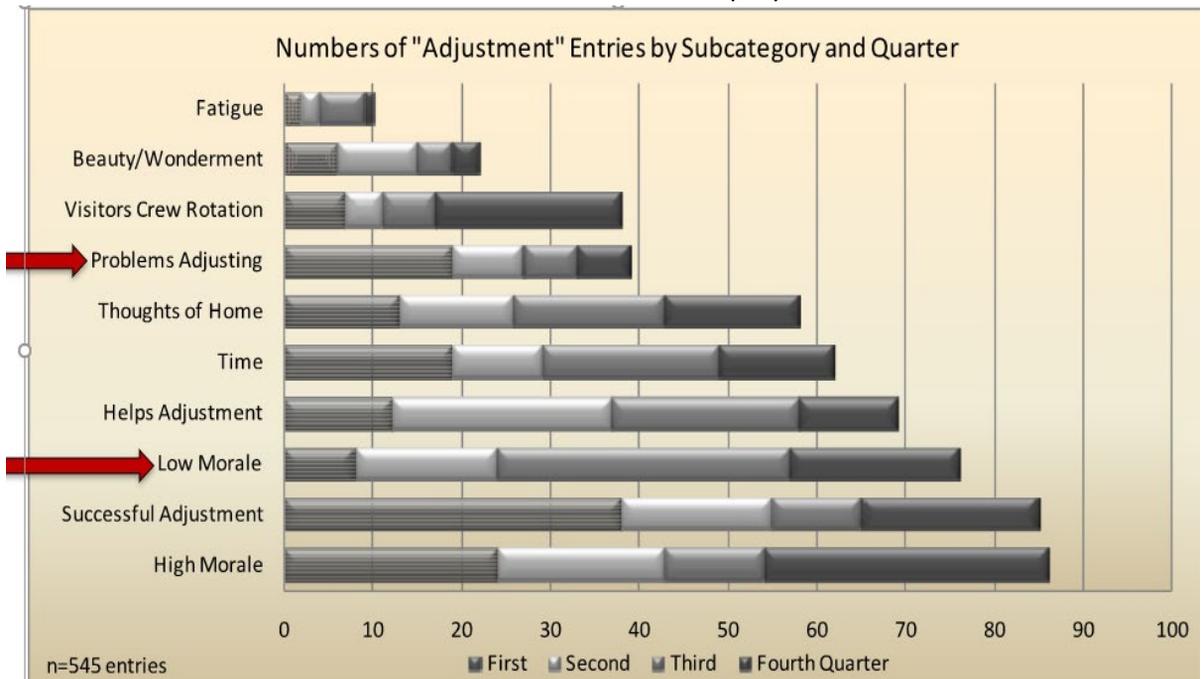
Background

Reported Behavioral Health Issues during Spaceflight

- Soyuz T10-Salyut 7 (1984): Crew reported possible hallucinations to mission control.
- Soyuz T14-Salyut 7 (1985): Depression may have contributed to evacuation and early termination of the mission.
- 2 of 7 (29%) of NASA Shuttle-Mir astronauts reported depressive symptoms. (Human Research Evidence Report, April 11, 2016)
- An STS Payload specialist became despondent when their experiment failed. The crew reported concerns about the potential for dangerous behavior, including opening a hatch. As a result, the STS hatches were fitted with locks.
- Delayed notification to a Russian crewmember of a family member’s death led to acute social withdrawal, depression, and isolation.
- Soyuz 21 reportedly ended prematurely due to unspecified "interpersonal issues" with the crew.

Reference NASA [OCHMO-TB-014 Behavioral Health Mishaps](#) and [OCHMO-TB-032 Cognitive Workload Assessment Methods](#) for additional information.

Astronaut Journals (ISS)



Stuster J. (2010) *Behavioral Issues Associated with Long-Duration Space Expeditions: Review and Analysis of Astronaut Journals -- Experiment 01-E104 (Journals): Final Report*, NASA Technical Document, TM-2010-216130

Application

Behavioral Health Support

The following outlines the mitigation strategies currently utilized to prevent decrements in behavioral health and performance of the crew during a spaceflight mission. It should be noted that current behavioral health support is provided before, during, and after the mission.

These behavioral health support services fall within six broad categories:

1. Selection

Includes things such as clinical and suitability evaluations of applicants throughout the selection process, and, while not currently facilitated, composition assignments for crew flight selections and composition strategies to address technical and non-technical compatibility of the crew.

2. Training

Training will ensure effective adaptation for both individuals and teams. Focuses include managing stress, dealing with cultural differences, working as an effective team, small group living, and optimizing sleep and circadian adaptation strategies.

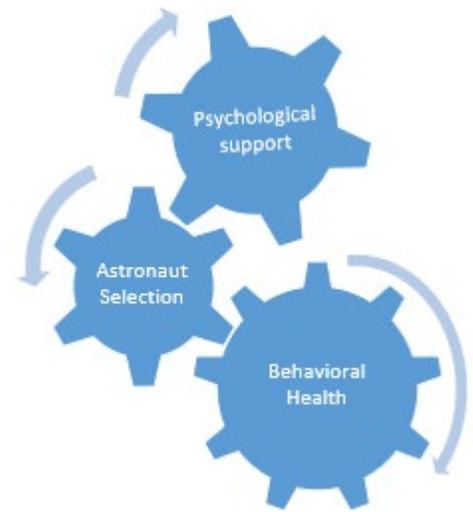
3. In-Flight Psychological and Neurobehavioral Support

Private psychological conferences (PPCs) are currently provided; additional psychological support includes crew care packages, crew support events (e.g., talking with movie star during the mission), and other support services (e.g., movies, books, magazines, favorite TV shows).

4. In-Flight Psychological and Neurobehavioral Monitoring

Cognitive testing is currently fulfilled by the monthly administration of the Spaceflight Cognitive Assessment Tool for Windows (**WinSCAT**). A preflight baseline is obtained for each astronaut and is then compared using a monthly in-flight test. A traumatic injury or illness on-orbit would dictate additional testing and assessment.

For missions beyond 6 months and/or beyond LEO, additional minimally obtrusive measures that objectively evaluate psychological and behavioral states within the mission context should be provided.



Relevant Technical Requirements
[V1 3001] Selection and Recertification; [V1 3002] Pre-Mission Preventive Health Care; [V1 3003] In-Mission Preventive Health Care; [V1 4011] Mission Cognitive Status; [V2 4014] Completion of Critical Tasks; [V1 5002] Crewmember Training; [V1 5008] Psychological Mission Training; [V1 6001] Circadian Shifting Operations and Fatigue Management; [V1 6004] Behavioral Health and Performance Provisions

From: NASA-STD-3001 Volume 1, Rev C

Application

5. Family Psychological Support:

The current program includes support for crewmembers' families; examples of support include Private Family Conferences (PFCs).

For missions beyond six months and/or beyond LEO, additional resources to support families, significant others, and friends and to facilitate crew-ground communication should be provided.

6. Repatriation:

Repatriation briefings are conducted pre-flight and normally 6 weeks before landing with the astronauts and their family members. Additional behavioral support is provided on an as-needed basis to facilitate the repatriation and reintegration of the astronauts with their families and work lives.



Astronauts aboard the ISS open a crew care package. Crew care packages are one means of keeping astronaut motivation and morale high, especially during long missions.

Credit: NASA



Photographing Earth and Journaling are important outlets for astronauts to manage their stress.

Credit: NASA

Relevant Technical Requirements

[V1 3004] In-Mission Medical Care; [V1 6002] Private Medical Communication (PMC) Schedule; [V1 6010] Psychological Communication Schedule

From: NASA-STD-3001 Volume 1, Rev C



Application

Habitat Design Guidance to Mitigate Various Psychological Stressors

| Psychological Stressor Category | Habitat Design Guidance |
|--|---|
| <p>Lack of Personal Space / Lack of Private Space</p> <p>Reference OCHMO-TB-025 Cabin Architecture and OCHMO-TB-041 Sleep Accommodations</p> | <ul style="list-style-type: none"> • Provide individual, separate sleeping/personal quarters w/auditory isolation and physical separation (if possible) for each crew member. • Separation of private spaces from spaces allocated for common, social areas, and congested translation paths is preferred. • Visual separation of private spaces from each other to allow for the perception of increased privacy. <p>[V2 7070] Sleep Accommodation; [V2 7071] Behavioral Health and Privacy, [V2 8001] Volume Allocation, [V2 8005] Functional Arrangement</p> |
| <p>Lack of Privacy in Waste & Hygiene Compartment</p> <p>Reference OCHMO-TB-042 Waste Management</p> | <ul style="list-style-type: none"> • Dedicated, private area for waste and hygiene with hygiene areas away from the dining area and medical station. • Separation of Waste & Hygiene Compartment area from translation areas. <p>[V2 7016] Personal Hygiene Capability, [V2 7017] Body Cleansing Privacy, [V2 7021] Body Waste Management System Location, [V2 7022] Body Waste Management Privacy</p> |
| <p>Lack of Sleep Quality and/or Quantity</p> <p>Reference OCHMO-TB-041 Sleep Accommodations</p> | <ul style="list-style-type: none"> • Provide restraints to secure blankets and maintain positioning, with a range from knees to chest to full body stature. • Provide individual control of the sleep environment in order to ensure adequate sleep and maintain well-being during missions. • Environmental factors such as noise, temperature, vibration, and light inhibit sleep and affect well-being in space. • Examples of sleep accommodations include clothing, bedding, ear plugs, light blockers, eye masks, etc. <p>[V1 4014] Completion of Critical Tasks, [V2 7070] Sleep Accommodation, [V2 6078] Continuous Noise Limits, [V2 6079] Crew Sleep Continuous Noise Limits, [V2 6080] Intermittent Noise Limits, [V2 6082] Annoyance Noise Limits for Crew Sleep, [V2 6083] Impulse Noise Limit, [V2 6092] Vibration Exposure Limits during Sleep, [V2 8049] Window Light Blocking, [V2 8055] Physiological Effects of Light (Circadian Entrainment), [V2 9057] Hearing Protection Provision</p> |



Application

Habitat Design Guidance to Mitigate Various Psychological Stressors

| Psychological Stressor Category | Habitat Design Guidance |
|--|--|
| <p>Sense of Poorly Placed Stowage</p> <p>Reference OCHMO-TB-025 Cabin Architecture</p> | <ul style="list-style-type: none"> • Ensure stowage types are near designated areas (i.e., food near dining). • Ensure that not all materials are stowed in one place. <p>[V2 7008] Food Preparation, [V2 7050] Stowage Provisions, [V2 7051] Personal Stowage</p> |
| <p>Long periods of low workload Bursts of high workload Lack of meaningful work /activity</p> <p>Reference OCHMO-TB-005 Usability, Workload, & Error and OCHMO-TB-032 Cognitive Workload</p> | <ul style="list-style-type: none"> • Provide individual development plans for each person's work goals, progress, and achievements. • Allocation of space and resources to accommodate everyone's work and activities (i.e., science, laboratory equipment, electronic curriculum, etc.). • The user must be able to cognitively process all information sources and physically execute all actions within the time required. <p>[V1 4011] Mission Cognitive Status, [V1 4014] Completion of Critical Tasks, [V1 6001] Circadian Shifting Operations and Fatigue Management, [V2 3006] Human-Centered Task Analysis, [V2 5007] Cognitive Workload , [V2 10200] Physical Workload</p> |
| <p>Lack of Individual Controls Over Temperature, Ventilation, Lighting, Humidity, or Noise</p> <p>Reference OCHMO-TB-002 ECLSS, OCHMO-TB-026 Lighting Design, and OCHMO-TB-035 Acoustics</p> | <ul style="list-style-type: none"> • Place individual controls and distribution vents in crew quarters and at workstations. <p>[V2 6013] Crew Performance Environmental Zone, [V2 6017] Atmospheric Control, [V2 6115] 24-Hour Noise Exposure Limits, [V2 6078] Continuous Noise Limits, [V2 6079] Crew Sleep Continuous Noise Limits, [V2 6080] Intermittent Noise Limits, [V2 6082] Annoyance Noise Limits for Crew Sleep, [V2 6083] Impulse Noise Limit [V2 8049] Window Light Blocking, [V2 8050] Window Accessory Replacement/Operation without Tools, [V2 8055], Physiological Effects of Light (Circadian Entrainment), [V2 8056] Lighting Controls, [V2 9057] Hearing Protection Provision</p> |
| <p>Limited Communication with Home</p> | <ul style="list-style-type: none"> • Communication system should be provided in each private quarter • System that facilitates voice and text should be provided • Private communication with family • Private space with pictures of family members <p>[V1 3004] In-Mission Medical Care, V2 Section 10.5 Audio, Communication, and Video Systems</p> |
| <p>Crew Composition</p> <p>Reference OCHMO-TB-034 Crew Selection and Recertification</p> | <ul style="list-style-type: none"> • Characteristics of the crew (team size, gender makeup, job roles, and cultural backgrounds), which are established before the mission, should be considered when defining the habitat requirements. <p>[V1 3001] Selection and Recertification, [V1 4011] Mission Cognitive Status</p> |



Application

Habitat Design Guidance to Mitigate Various Psychological Stressors

| Psychological Stressor Category | Habitat Design Guidance |
|---|---|
| Lack of Hygiene Separation Reference OCHMO-TB-042 Waste Management | <ul style="list-style-type: none"> • Provide separation between clean areas (medical treatment, food prep, crew quarters, etc.) and dirty areas (hygiene, dusty areas, etc.) • Provide olfactory or other partitions to prevent contamination of clean areas. This can include closed, separately ventilated areas. <p>[V2 7016] Personal Hygiene Capability, [V2 7017] Body Cleansing Privacy, [V2 7021] Body Waste Management System Location, [V2 7022] Body Waste Management Privacy, [V2 8005] Functional Arrangement</p> |
| Lack of "Backup Plan" / "Rescue Scenario" Reference OCHMO-TB-020 Radiation Protection and OCHMO-TB-017 Automated and Robotic Systems | <ul style="list-style-type: none"> • Placement of hatches to allow for alternate escape routes. • Provision of radiation shelter. <p>[V2 6022] Atmospheric Monitoring and Alerting Parameters, [V2 6095] Ionizing Radiation Protection Limit, [V2 6162] Personal Monitoring of Space Radiation Exposure, [V2 6164] Alerting of Elevated Exposure Rates, [V2 6165] External Space Weather Monitoring, [V2 11010] EVA Suit Radiation Monitoring, V2 Section 10.6 Automated and Robotic Systems</p> |
| Crew Mortality/Death of a Crewmember Reference OCHMO-TB-012 Mortality Related to Human Spaceflight | <ul style="list-style-type: none"> • Facilities and plans for handling deceased crewmembers that are socially, psychologically, biologically, culturally, and physically acceptable are to be established during system development. • The plan must prioritize minimizing the risks to surviving crewmembers (including psychological harm). <p>[V1 3050] Pre-Mission Crew Mortality Plan, [V1 3052] In-Mission Forensic Sample Collection, [V1 3055] Surviving Crew Support</p> |

Reference NASA [OCHMO-TB-025 Cabin Architecture](#) and [OCHMO-TB-00007 Mission Duration](#) for additional information on designing habitats for long-duration missions.



Back-Up



Major Changes Between Revisions

Rev A → Rev B

- Updated information and standards to be consistent with NASA-STD-3001 Volume 1 Rev C and Volume 2 Rev D.

Original → Rev B

- Updated information and standards to be consistent with NASA-STD-3001 Volume 1 Rev B and Volume 2 Rev C.



View the current versions of NASA-STD-3001 Volume 1 & Volume 2 on the [OCHMO Standards website](#)

Referenced Technical Requirements

NASA-STD-3001 Volume 1 Revision C

[V1 3001] Selection and Recertification Crewmembers shall be medically and psychologically selected and annually recertified following the guidance in OCHMO-STD-100.1A, NASA Astronaut Medical Standards Selection and Annual Recertification.

[V1 3002] Pre-Mission Preventive Health Care Pre-mission preventive strategies shall be used to reduce in-mission and long-term health medical risks including, but not limited to: (see NASA-STD-3001 Volume 1 Rev C for full technical requirement).

[V1 3003] In-Mission Preventive Health Care All programs shall provide training, in-mission capabilities, and resources to monitor physiological and psychosocial well-being and enable delivery of in-mission preventive health care, based on epidemiological evidence-based probabilistic risk assessment (PRA), individual crewmember needs, clinical practice guidelines, flight surgeon expertise, historical review, mission parameters, and vehicle derived limitations. These analyses consider the needs and limitations of each specific vehicle and design reference mission (DRM) with particular attention to parameters such as mission duration, expected return time to Earth, mission route and destination, expected radiation profile, concept of operations, and more. In-mission preventive care includes, but is not limited to: (see NASA-STD-3001 Volume 1 Rev C for full technical requirement).

[V1 3004] In-Mission Medical Care All programs shall provide training, in-mission medical capabilities, and resources to diagnose and treat potential medical conditions based on epidemiological evidence-based PRA, individual crewmember needs, clinical practice guidelines, flight surgeon expertise, historical review, mission parameters, and vehicle-derived limitations. These analyses consider the needs and limitations of each specific vehicle and design reference mission (DRM) with particular attention to parameters such as mission duration, expected return time to Earth, mission route and destination, expected radiation profile, concept of operations, and more. In-mission capabilities (including hardware and software), resources (including consumables), and training to enable in-mission medical care, and behavioral care, are to include, but are not limited to: (see NASA-STD-3001 Volume 1 Rev C for full technical requirement).

[V1 3050] Pre-Mission Crew Mortality Plan The program shall develop and execute a Crew Mortality Plan and determine legal jurisdiction prior to each mission (including preflight activities, launch, operations, and landing).

[V1 3052] In-Mission Forensic Sample Collection The program shall have the capability to obtain in-mission forensic evidence from a deceased crewmember and return this evidence to Earth.

[V1 3055] Surviving Crew Support The program shall provide behavioral health support to the deceased crewmembers' family, surviving crewmembers, and support team in-mission and post-mission.

[V1 4011] Mission Cognitive Status Pre-mission, in-mission, and post-mission crew behavioral health and crewmember cognitive state shall be within clinically accepted values as judged by behavioral health evaluation.

[V1 4014] Completion of Critical Tasks The planned number of hours for completion of critical tasks and events, workday, and planned sleep period shall have established limits to assure continued crew health and safety.



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Referenced Technical Requirements

NASA-STD-3001 Volume 1 Revision C

[V1 5002] Crewmember Training Beginning with the astronaut candidate year, general medical training, including, but not limited to, first aid, cardiopulmonary resuscitation (CPR), altitude physiological training, carbon dioxide exposure training, familiarization with medical issues, procedures of space flight, psychological training, and supervised physical conditioning training shall be provided to the astronaut corps.

[V1 5008] Psychological Mission Training Specific pre-mission briefings and training shall be provided as appropriate to the commander (CDR), CMOs, crewmembers, key ground personnel, and crew families concerning the significant psychological and social phenomena that may arise in all phases of a mission.

[V1 6001] Circadian Shifting Operations and Fatigue Management Crew schedule planning and operations shall be provided to include circadian entrainment, work/rest schedule assessment, task loading assessment, countermeasures, and special activities.

[V1 6002] Private Medical Communication Schedule Private medical communications shall be scheduled on a routine basis, as determined by the Flight Surgeon, at a frequency dictated for short or long-duration missions.

[V1 6004] Behavioral Health and Performance Provisions Program shall implement psychological/behavioral health support programs for the crewmembers, key ground personnel, and crewmember families throughout the mission.

[V1 6010] Psychological Communication Schedule A PPC shall be scheduled on a routine basis, as determined by the Behavioral Health Provider, at a frequency dictated for short or long duration missions.

NASA-STD-3001 Volume 2 Revision D

[V2 3006] Human-Centered Task Analysis Each human space flight program or project shall perform a human-centered task analysis to support systems and operations design.

[V2 4102] Functional Anthropometric Accommodation The system shall ensure the range of potential crewmembers can fit, reach, view, and operate the human systems interfaces by accommodating crewmembers with the anthropometric dimensions and ranges of motion as defined in data sets in Appendix E, Physical Characteristics and Capabilities, Sections E.2 and E.3.

[V2 5007] Cognitive Workload The system shall provide crew interfaces that result in Bedford Workload Scale ratings of 3 or less for nominal tasks and 6 or less for tasks performed under degraded system conditions.

[V2 10200] Physical Workload The system shall provide crew interfaces that result in a Borg-CR10 rating of perceived exertion (RPE) of 4 (somewhat strong) or less.

[V2 6013] Crew Performance Environmental Zone The system shall be capable of reaching atmospheric humidity and temperatures of nominally occupied habitable volumes within the zone provided in Figure 6.2-3—Crew Performance Environmental Zone, during all nominal operations, excluding suited operations, ascent, entry, landing, and post landing.

[V2 6017] Atmospheric Control The system shall allow for local and remote control of atmospheric pressure, humidity, temperature, ventilation, and ppO₂.



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Referenced Technical Requirements

NASA-STD-3001 Volume 2 Revision D

[V2 6022] Atmospheric Monitoring and Alerting The system shall alert the crew locally and remotely when atmospheric parameters, including atmospheric pressure, humidity, temperature, ppO₂, and ppCO₂ are outside safe limits.

[V2 6109] Water Quantity The system shall provide a minimum water quantity as specified in Table 6.3-1—Water Quantities and Temperatures, for the expected needs of each mission, which should be considered mutually independent.

[V2 6110] Water Temperature The system shall provide the appropriate water temperature as specified in Table 6.3-1—Water Quantities and Temperatures, for the expected needs of each mission and task.

[V2 6115] 24-Hour Noise Exposure Limits The noise exposure level (not including impulse noise) at the crewmember's head, calculated over any 24-hour period, except during launch, entry, and abort operations, shall be limited such that the noise dose (D) is ≤ 100 (see NASA-STD-3001 Vol 2 Rev D for equations).

[V2 6078] Continuous Noise Limits In spacecraft work areas, where good voice communications and habitability are required, SPLs of continuous noise (not including impulse noise) shall be limited to the values given by the Noise Criterion (NC)-50 curve in Figure 6.6-1—NC Curves, and Table 6.6-3—Octave Band SPL Limits for Continuous Noise, dB re 20 μ Pa (micropascals); hearing protection cannot be used to satisfy this requirement.

[V2 6079] Crew Sleep Continuous Noise Limits For missions greater than 30 days, SPLs of continuous noise shall be limited to the values given by the NC-40 curve (see Figure 6.6-1—NC Curves, and Table 6.6-3—Octave Band SPL Limits for Continuous Noise, dB re 20 μ Pa) in crew quarters and sleep areas. Hearing protection cannot be used to satisfy this requirement.

[V2 6080] Intermittent Noise Limits For hardware items that operate for eight hours or less (generating intermittent noise), the maximum noise emissions (not including impulse noise), measured 0.6 m from the loudest hardware surface, shall be determined according to Table 6.6-4—Intermittent Noise A-Weighted SPL and Corresponding Operational Duration Limits for any 24-hour period (measured at 0.6 m distance from the source). Hearing protection cannot be used to satisfy this requirement.

[V2 6082] Annoyance Noise Limits for Crew Sleep With the exception of communications and alarms, the system shall limit impulse and intermittent noise levels at the crewmember's head location to 10 dB above background noise levels during crew sleep periods. Hearing protection cannot be used to satisfy this requirement.

[V2 6083] Impulse Noise Limit The system shall limit impulse noise measured at the crewmember's head location to less than 140 dB peak SPL during all mission phases except launch and entry. Hearing protection cannot be used to satisfy this requirement.

[V2 6092] Vibration Exposure Limits during Sleep The system shall limit vibration to the crew such that the acceleration between 1.0 and 80 Hz in each of the X, Y, and Z axes, weighted in accordance with ISO 20283-5, Mechanical Vibration—Measurement of Vibration on Ships; Part 5 - Guidelines for the Measurement, Evaluation, and Reporting of Vibration with Regard to Habitability on Passenger and Merchant Ships, Annex A, is less than 0.01 g (0.1 m/s²) RMS for each two-minute interval during the crew sleep period.



View the current versions of NASA-STD-3001 Volume 1 & Volume 2 on the [OCHMO Standards website](#)

Referenced Technical Requirements

NASA-STD-3001 Volume 2 Revision D

[V2 6093] Vibration Limits for Performance The system shall ensure the appropriate level of crew task performance (e.g., motor control accuracy and precision, vision/readability, speech clarity, attentional focus) during vibration by evaluating task performance under all expected (nominal and off-nominal) vibration levels.

[V2 6095] Ionizing Radiation Protection Limit The program shall set system design requirements to prevent potential crewmembers from exceeding PELs as set forth in NASA-STD-3001, Volume 1.

[V2 6161] Intravehicular Area Monitoring of Space Radiation Exposure The program shall monitor the radiation exposure produced by galactic cosmic rays, solar energetic particles, trapped radiation, and neutrons in habitable volumes as referenced in Table 6.8-1—Space Radiation Monitoring Requirements Mission Location vs. Required Monitoring.

[V2 6162] Personal Monitoring of Space Radiation Exposure The program shall monitor the radiation exposure produced by galactic cosmic rays, solar energetic particles, and trapped radiation received by individual crew members as referenced in Table 6.8-1—Space Radiation Monitoring Requirements Mission Location vs. Required Monitoring.

[V2 6164] Alerting of Elevated Exposure Rates The radiation monitoring system shall alert the crew and operations teams when radiation exposure rates exceed predefined thresholds.

[V2 6165] External Space Weather Monitoring The program shall monitor the in-situ extravehicular space weather environment including the external exposure rates, electron flux spectra, and proton flux spectra.

[V2 7002] Food Acceptability The system shall provide food that is acceptable to the crew for the duration of the mission.

[V2 7008] Food Preparation The system shall provide the capability for preparation, consumption, and stowage of food.

[V2 7012] Dining Accommodations The system shall provide adequate volume and accommodations for crewmembers to dine together.

[V2 7016] Personal Hygiene Capability Personal hygiene items shall be provided for each crewmember, along with corresponding system capabilities for oral hygiene, personal grooming, and body cleansing.

[V2 7017] Body Cleansing Privacy The system shall provide for privacy during personal hygiene activities.

[V2 7021] Body Waste Management System Location The body waste management system shall be isolated from the food preparation and consumption areas for aesthetic and hygienic purposes.

[V2 7022] Body Waste Management Privacy The system shall provide privacy during use of the body waste management system.

[V2 7038] Physiological Countermeasures Capability The system shall provide countermeasures to meet crew bone, muscle, sensorimotor, thermoregulation, and aerobic/cardiovascular requirements defined in NASA-STD-3001, Volume 1.

[V2 7050] Stowage Provisions The system shall provide for the stowage of hardware and supplies, to include location, restraint, and protection for these items.

[V2 7051] Personal Stowage The system shall provide a stowage location for personal items and clothing.

[V2 7061] Nomenclature Consistency The nomenclature used to refer to the items tracked by the inventory management system shall be consistent with procedures and labels.



View the current versions of NASA-STD-3001 Volume 1 & Volume 2 on the [OCHMO Standards website](#)

Referenced Technical Requirements

NASA-STD-3001 Volume 2 Revision D

[V2 7062] Unique Item Identification Items that need to be uniquely identified shall have a unique name.

[V2 7063] Interchangeable Item Nomenclature Items within the inventory management system that are identical and interchangeable shall have identical nomenclature.

[V2 7070] Sleep Accommodation The system shall provide volume, restraint, accommodations, environmental control (e.g., vibration, lighting, noise, and temperature), and degree of privacy for sleep for each crewmember to support overall crew health and performance.

[V2 7071] Behavioral Health and Privacy For long-duration missions (>30 days), individual privacy facilities shall be provided.

[V2 7073] Partial-g Sleeping The system shall provide for horizontal sleep surface areas for partial-g and 1-g environments.

[V2 8001] Volume Allocation The system shall provide the defined habitable volume and layout to physically accommodate crew operations and living.

[V2 8005] Functional Arrangement Habitability functions shall be located based on the use of common equipment, interferences, and the sequence and compatibility of operations.

[V2 8013] Intravehicular Translation Paths The system shall provide intravehicular activity (IVA) translation paths that allow for safe and unencumbered movement of suited and unsuited crew and equipment.

[V2 8033] Restraints for Crew Tasks The system shall provide restraints for expected crew operations.

[V2 8049] Window Light Blocking Each system window shall provide a means to prevent external light from entering the crew compartment, such that the interior light level can be reduced to 2.0 lux at 0.5 m (20 in) from each window.

[V2 8050] Window Accessory Replacement/Operation without Tools System window accessories designed for routine use shall be operable by one crewmember and be removable or replaceable without the use of tools.

[V2 8055] Physiological Effects of Light (Circadian Entrainment) The system shall provide the levels of light to support the physiological effects of light in accordance with Table 8.7-2—Physiological Lighting Specifications.

[V2 8056] Lighting Controls Lighting systems shall have on-off controls.

[V2 9057] Hearing Protection Provision Appropriate personal hearing protection shall be provided to the crew during all mission phases for contingency or personal preference.

[V2 11010] EVA Suit Radiation Monitoring The suit shall provide or accommodate radiation monitoring and alerting functions to allow the crew to take appropriate actions.

Section 10: Crew Interfaces



Reference List

1. NASA Human Health, Medical, and Performance Spaceflight Standards – NASA-Standard 3001 Volumes 1 and 2. <https://www.nasa.gov/directorates/esdmd/hhp/human-spaceflight-and-aviation-standards/>
2. NASA-STD-3001 Human Integration Design Handbook, Rev 1. <https://www.nasa.gov/organizations/ochmo/human-integration-design-handbook/>
3. Evidence Report: Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders, April 11, 2016. Behavioral Health and Performance. https://www.nasa.gov/exploration/humanresearch/elements/research_info_element-bhp.html
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